Towed ADCP data from Isla Natividad collected in July of 2018

Website: https://www.bco-dmo.org/dataset/892237
Data Type: Other Field Results
Version: 1
Version Date: 2023-03-21

Project
» Collaborative Research: Evaluating how abalone populations in the California Current are structured by the interplay of large-scale oceanographic forcing and nearshore variability (Abalone Safe Places)

Contributors	Affiliation	Role
Valle-Levinson, Arnoldo	University of Florida (UF)	Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Towed ADCP data from Isla Natividad collected in July of 2018. These results were published in Valle-Levinson et al. (2022).

Table of Contents

Coverage

Spatial Extent: **N**:27.89 **E**:-115.15 **S**:27.85 **W**:-115.2
Temporal Extent: 2018-07-25 - 2018-07-29

Methods & Sampling

All files are from the East Side of the Island (July 25-27, 2018), except for "West_Side_0_000_ASC.TXT" (Jul 28-29, 2018). The files are readily readable and their format follows the default from the WinRiver software of Teledyne Instruments.

Location: The study was performed on Isla Natividad, found off Punta Eugenia, the most prominent point in the middle of the western coast of the Baja California peninsula (Fig. 1a in Valle-Levinson et al., 2022), near the southernmost limit of the California Current.

Methods & Sampling:

Data were collected over two headlands at either side of Isla Natividad (Fig. 1b 'Location' in Valle-Levinson et al., 2022). The sampling strategy consisted of three offshore transects around headlands on the eastern (1E, 2E, 3E) and western (1W, 2W, 3W) coast of the island (Fig. 1b in 'Location' in Valle-Levinson et al., 2022). Both headlands were located over the southern half of the island (Fig. 1b 'Location' in Valle-Levinson et al., 2022) but only the western headland had dense kelp (*Macrocystis pyrifera,* LSID urn:lsid:marinespecies.org:taxname:232231) forests around it. The objective of the sampling strategy was to capture variations of the flow around the headland throughout full tidal cycles. Because the study area is dominated by mixed tides with semidiurnal dominance, sampling was designed to cover at least one 25-hr cycle. This strategy also allowed the separation of tidal and residual or subtidal signals (e.g., Valle-Levinson and Atkinson, 1999) to identify flow fields typical of headland upwelling. Wind conditions should be sufficiently weak (<7-8 m/s) to allow towed-ADCP data collection. In fact, wind conditions during ADCP sampling averaged <3 m/s, according to data from a station 20 km away, at Cedros Island.

Instruments:
Each transect was covered by Acoustic Doppler Current (ADCP) profiles of water velocity, acoustic backscatter, and values of surface water temperature. Raw data were recorded at 2 Hz while the ADCP was towed on a catamaran on the side of a boat from the local fisher cooperative. Acceptable data were trimmed to allow 3-beam solution values with >70% good and <100 m2/s transport. On the east side of the island, transects were traversed at ~ 2m/s over waters with minimal kelp presence.

Problems/Issues:

East-side transects were covered on July 25th, 2018, for 12 h, because of an emergency for the fishing cooperative, and then re-occupied from July 26 to July 27, 2018. Transects on the west side were sampled over dense kelp forests (see photo on Figure 1b in Valle-Levinson et al., 2022). Sampling was executed interruptedly, again because of cooperative emergencies, from July 28th to July 29th, 2018.

Deployment Description:

Data were collected with a local cooperative boat over two headlands at either side of Isla Natividad, off the Baja California western coast . The sampling strategy consisted of three offshore transects around headlands on the eastern and western coast of the island. Both headlands were located over the southern half of the island but only the western headland had dense kelp (*Macrocystis pyrifera)* forests around it. The objective of the sampling strategy was to capture variations of the flow around the headland throughout full tidal cycles. Because the study area is dominated by mixed tides with semidiurnal dominance, sampling was designed to cover at least one 25-hr cycle between July 25 and 29, 2018. Chief scientist: Arnoldo Valle-Levinson.

Data Processing Description

The survey on the east side of the island extended mainly over three transects around a headland. Transect 1E was a few tens of meters to the west of the headland, while 2E and 3E were to the east. Sampling covered one full diurnal tidal cycle with ensembles of 25 velocity profiles and temperature values. Boat and ADCP speeds of 2 m/s on the east side represented ensembles of ~12.5 s (i.e., 25 profiles) with a spatial resolution of 25 m. Surface water temperature and velocities were used to construct Hovmöller or phase diagrams (along-transect distance vs time) that provided information on the offshore temperature structure and its variation with time at each of the three transects. These diagrams provided the first diagnosis for headland upwelling. Typical data processing (e.g., Valle-Levinson and Atkinson, 1999) was followed to obtain the vertical structure of tidal residual currents along each of the three transects. Residual flow contours provided a second diagnostic for headland upwelling.

On the west side of the island, in contrast, transects were mostly sampled over kelp forests and had a similar spatial extent as on the east side. Data were collected while towing at mean speeds of ~1 m/s, slower than on the east side because of the kelp density. Transducer pairs in the ADCP were nearly perpendicular and parallel to flow direction, allowing resolution of gaps in kelp. Water velocity and backscatter profiles were used to identify the predominant direction and vertical structure of overall currents in the region sampled. This was done with 80-profile ensembles for a horizontal resolution of ~40 m. Data coverage of <12 continuous hours precluded separation of tidal residual currents from tidal currents. Furthermore, surface temperature data were processed to achieve a spatial resolution of 4 m by averaging 8 profiles. Surface temperature values and ~40-m resolution surface velocities were also arranged in Hovmöller diagrams to diagnose headland upwelling. Surface velocity data with 4-m resolution resulted in noisy phase diagrams because of flow ducting through kelp.

On the west side, backscatter profiles with 4-m horizontal resolution were also used as proxy for kelp presence. Backscatter signals helped detect kelp grouping and their effect on flows. Backscatter profiles $B(z, t)$ were collapsed into absolute values of depth-averaged anomalies $|I|$. $|I|$ was calculated by vertically averaging $B(z, t)$ to obtain $Ba(t)$. Ba was transformed, following Pleuddemann and Pinkel (1989), and Rippeth and Simpson (1998), to $Bt(t) = 10 \log(Ba)$. Finally, $|I|$ was calculated at each time from the absolute value of $[Bt - < Bt >]$, where $<Bt>$ is a horizontal low-pass filtered version of Bt centered, arbitrarily, at 40 m. This horizontal filtering eliminated the trend in backscatter observed from the beginning to the end of each transect repetition. Gaps in |*I*| at the surface remained practically depth-independent, suggesting a reliable representation of kelp fronds.

[table of contents | back to top]

Data Files

File
Teledyne ADCP TXT file format filename: ADCP_txt_files.zip (ZIP Archive (ZIP), 10.12 MB) MD5:b72545ba4b7c3cfe19e2ada91291572f Teledyne ADCP files in TXT format as output by WinRiver software. All files are from the East Side of the Island (July 25-27, 2018), except for "West_Side_0_000_ASC.TXT" (Jul 28-29, 2018). The files are readily readable and their format follows the default from the WinRiver software of Teledyne Instruments. See supplementary file "ADCP_format_description.pdf" for a technical description of this format. These files were also published individually as part of DOI: 10.5281/zenodo.5182648.

[table of contents | back to top]

Supplemental Files

File
Matlab conversion script filename: bronze.m (MATLAB Programming Script (.m), 2.16 KB) MD5:65189bad10ffdcae3259ab925afff2f7 Matlab routine that converts the ASCII txt files from WinRiver (see ADCP_txt_files.zip) file to a regular matrix of data.
ADCP Format Description filename: ADCP_format_description.pdf (Portable Document Format (.pdf), 224.21 KB) MD5:873d021e687a9364e96fbcd15cf21c6d Description of Teledyne ADCP files in TXT format included in the zip file "ADCP_txt_files.zip."

[table of contents | back to top]

Related Publications

U.S Geological Survey (2022). II. OSW Hydroacoustics: WinRiver II (n.d). Retrieved March 21, 2023, from https://hydroacoustics.usgs.gov/movingboat/WinRiverII.shtml
Software

Valle-Levinson, A., & Atkinson, L. P. (1999). Spatial Gradients in the Flow over an Estuarine Channel. Estuaries, 22(2), 179. https://doi.org/10.2307/1352975
Methods

Valle-Levinson, A., Daly, M. A., Juarez, B., Tenorio-Fernandez, L., Fagundes, M., Woodson, C. B., & Monismith, S. G. (2022). Influence of kelp forests on flow around headlands. Science of The Total Environment, 825, 153952. https://doi.org/10.1016/j.scitotenv.2022.153952
Results

[table of contents | back to top]

Related Datasets

Different Version

Valle-Levinson, A. (2021). *Data from Isla Natividad*. Zenodo. https://doi.org/10.5281/ZENODO.5182648

https://doi.org/10.5281/zenodo.5182648

[table of contents | back to top]

Parameters

Parameters for this dataset have not yet been identified

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	600 kHz Teledyne RDI Instruments ADCP
Generic Instrument Name	Acoustic Doppler Current Profiler
Generic Instrument Description	The ADCP measures water currents with sound, using a principle of sound waves called the Doppler effect. A sound wave has a higher frequency, or pitch, when it moves to you than when it moves away. You hear the Doppler effect in action when a car speeds past with a characteristic building of sound that fades when the car passes. The ADCP works by transmitting "pings" of sound at a constant frequency into the water. (The pings are so highly pitched that humans and even dolphins can't hear them.) As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument. Due to the Doppler effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return. Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to bounce back and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings. (More from WHOI instruments listing).

[table of contents | back to top]

Project Information

Collaborative Research: Evaluating how abalone populations in the California Current are structured by the interplay of large-scale oceanographic forcing and nearshore variability (Abalone Safe Places)

Coverage: Pacific Coast of Baja California (26 N to 32 N)

NSF Award Abstract:
Oceanographic variability is increasingly recognized as a driver of change in marine ecosystems. Understanding the effects of this oceanographic variability and its extremes on organisms, populations, ecosystems and the critical services they deliver is of great scientific interest and pivotal for resource management and policy. The overarching goal of this project is to determine how small-scale heterogeneity in habitat quality and site-specific vulnerability to extreme oceanographic conditions might help identify safe spaces and protect coastal populations and fisheries from the detrimental effects of increasing frequency, intensity and durations of extreme oceanographic conditions. This project will combine detailed nearshore oceanographic studies with ecological experiments and coupled biophysical modeling to advance

understanding of the drivers of local oceanographic variability and consequent effects on coastal marine animals. The research will determine how multiple, potentially stressful, environmental drivers co-vary in the field and how such variation affects the population dynamics of coastal species. Specifically, this project will provide key insights regarding how changes in ocean acidification, dissolved oxygen and temperature will affect green and pink abalone, an ecologically and economically important resource in the southern California Current. Team members will work with partner non-governmental organizations, resource agencies, and fishing cooperative federations to disseminate results and incorporate data and insights into fisheries management and adaptation initiatives in Baja California, Mexico and in California, USA. This project will also support the training and professional development of underrepresented groups at the high school, undergraduate, graduate and postdoctoral levels through direct involvement in research, intensive courses and international workshops.

Despite large-scale drivers and regional perturbations, local variability in ocean conditions may be a major driver of the overall performance and vulnerability of coastal marine species. Research performed as part of this project will test two specific hypotheses: (1) The relative influences of upwelling versus tides, as mediated by coastal geometry and structural complexity associated with rocky reefs and kelp forests act to create high local variability in physical conditions, at scales of 10s-1000s meters; and (2) Local variability in oceanographic conditions results in high local patchiness in the performance of sedentary marine organisms, providing for safe spaces in the face of escalating heat waves, hypoxia, and acidification, that have caused recent mass mortalities in multiple species across the California Current region. Integrated oceanographic-ecological field studies will be conducted along the coast of Baja California, Mexico, using green and pink abalone (Haliotis fulgens, H. corrugata) as model species. Complementary laboratory experiments will evaluate how different exposure regimes (frequency, intensity and duration of high temperature, and/or low dissolved oxygen and acidity events) may affect the demography and persistence of abalone populations under current and future environments. Coupled biophysical and population models will integrate results from the field and laboratory experiments to understand how local variability in ocean conditions affects population dynamics over longer periods. The research will advance the understanding of factors affecting the resilience coastal species by (1) ascertaining how large-scale oceanographic phenomena manifest in ocean conditions (dissolved oxygen, acidity, temperature) at local scales that are most relevant to coastal marine ecosystems and (2) determining the effects of current, and expected future, ocean conditions and variability on important marine species.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1737090

[table of contents | back to top]